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TECHNOLOGICAL MODERNISATION, INNOVATION AND RESEARCH AND DEVELOPMENT AS FACTORS OF COMPETITIVENESS IN THE ECONOMY OF HUNGARY

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Summary

Relationship between technological modernisation, innovations and competitiveness of the Hungarian economy from the perspectives required for strategy building is described in this study[1] from several perspectives.

The introductory chapter describing the most important terms outlines the concept of the national innovation system (National Innovation System, NIS) that has been regarded the standard point of departure by key economic policy makers of advanced market economies for the past decade and half. Key factor of the NIS is how competitiveness is influenced by the quality and quantity of links and relationships among elements of the 'national' system creating innovation. Unimpeded flow of knowledge plays an outstanding role in these processes. The most essential mechanisms of the flow of knowledge contributing to the increase of competitiveness include joint research involving businesses and research organisations as well as cooperation between public and private sector, technology diffusion and mobility of human resources.

Chapter II is devoted to a discussion of features of the Hungarian innovation system from macro- and micro-economic perspectives. Hungarian macro-economic statistics (e.g. R&D spending, patents, publications, high technology exports) will be presented together with available corresponding statistics from the Czech Republic, Poland, Slovakia, Slovenia, Belgium, Greece and Austria. A comparison of available data reveals that levels of research and development expenditures are generally low, research and scientific sub-system of the innovation system is rather short of funds. It is also shown by statistics that more developed and advanced a country is the higher the share of researchers in the private sector within the total number of researchers will be and the relevant Hungarian data belong to the worst such statistics among the OECD countries. Furthermore, the so-called European paradox is also reflected by the Hungarian system: despite the old continent's generation of a balanced 'scientific' output, it is not sufficiently capable of innovation and of practical application of scientific results. The info-communication infrastructure is one of the most important 'environmental' variables of the NIS, and its macro data (Internet access, computer ownership, telephone line coverage) are not very encouraging in respect of the economy of Hungary. Micro level information is based on a business survey from September 2002. Significant relationships have been identified between competitiveness of manufacturing enterprises in Hungary, their product innovations as well as their technological processes. Introduction of a new technology has a positive impact on competitiveness: according to empirical data almost two thirds of all enterprises have introduced new technologies in recent years and an overwhelming majority of these businesses have products that are competitive in the EU markets as well. It should be noted, however, that competitiveness of more than two thirds of services and products relies on low prices.

Chapter III, covering a range of possible economic policy steps, outlines arguments of the author concerning the necessity of a strong enterprise orientation in

1 Paper was submitted in March 2003

the R&D sector along with arguments stressing that the entire economic policy governance should be permeated by an innovation system concept. In the current state the system is rather modest and is substantially underperforming in comparison to its ‘capabilities’. There are tasks to be carried out both on supply and demand side, but the largest available unexploited opportunities lie in the improvement of frame conditions that do not require substantial financial input.

1. Terms and concepts - subject of the analysis

By far the largest share of the Hungarian gross domestic product (GDP) is generated by actors of the private sector (in other words, by small and medium-sized enterprises). Accordingly 'competitiveness' of enterprises is a key factor of the convergence of Hungary. But what precisely is meant by competitiveness?

For example, the following definition has been worked out by OECD [1992] for (macro-level) competitiveness: 'the capability of generating products and services proving to be successful in foreign trade competition, whilst retaining or increasing the level of domestic real income'. Aiginger [1995] came up with a similar definition: 'the capability of maintaining market share whilst realising high and sustainable incomes under improving social and environmental circumstances'. Porter [1990] and Krugman [1994], however, regard the term macro-level competition as one without substantial meaning and they argue that competitiveness should be measured at the level of individual businesses. For the purposes of our study the definitions elaborated by Chikán (See: Competitiveness … [2001]) will be accepted:

- competitiveness at the level of a national economy means the capability of the economy of creating, producing, distributing and/or providing products in line with the requirements entailed by international trade, whilst ensuring growth of the yields of its factors of production.
- competitiveness at the level of a single business means a capability of detecting environmental and internal changes (within the organisation itself) in a way as will enable the generation of a flow of profits supporting long term operability. A company is competitive if it is capable of meeting higher quality, time and cost criteria than those met by its competitors, in a long run.

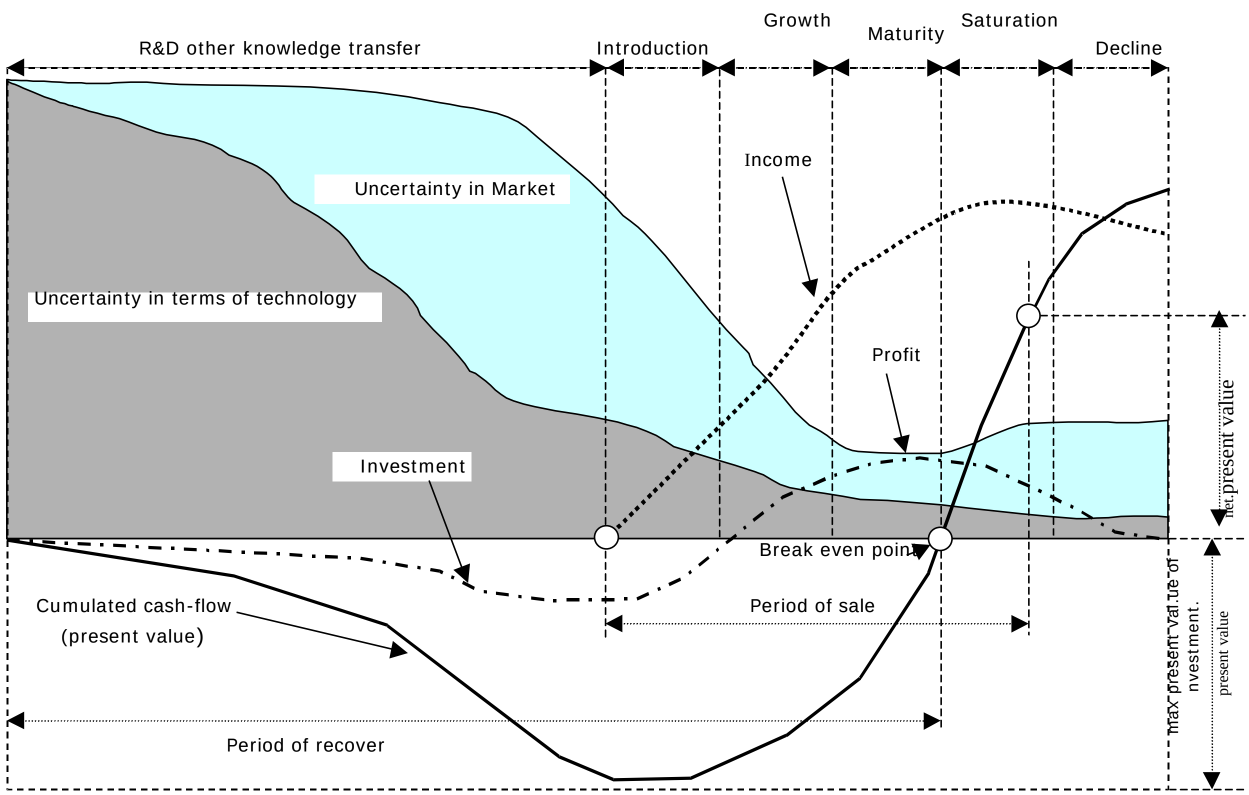
Although no universally accepted definition of competitiveness has been developed so far, the concept of competitiveness - of meanings similar to those outlined above - is used in numerous analyses. It is used both at micro levels (e.g. Szalavetz [1999]), sectoral level (e.g. the majority of the volumes of the series entitled 'Competing with the world' („Versenyben a világgal") summarised by Czakó [1997]) and at a macro level (e.g. OECD [1998], [1999], World Competitiveness… [2001]) alike.[2] Nevertheless, two aspects of competitiveness need to be distinguished. One of the two is related to costs, i.e. the market actor (national economy) that is capable of selling products in the market at lower costs is more competitive. The other aspect of competitiveness is somewhat more difficult to explain. This aspect may be referred to as 'quality competitiveness' for simplicity's sake: if a product to be sold on the market is a novelty, if it is of high quality and the entity (or country!) selling/exporting the product has a favourable image in the market and operating

2 The theory, methodology background of and international literature on competitiveness is dealt with by numerous books available in Hungarian (e.g. Szentes [1999], Török [1999]), articles in periodicals (e.g. Boda–Pataki [1995], Hoványi [1999], Török [1989], [1997]), other studies (e.g. Gáspár–Kacsirek [1997], Majoros [1997], the detailed description is beyond the scope of this paper.

good sales channels, the product will be competitive and will sell better in the market even if it is more expensive than competing products.[3]

Innovation, i.e. 'the conversion of an idea into a new or modernised product introduced to the market or into a new or improved process in industry or trade, or a novel approach to a social service' (see OECD [1997/b], in Hungarian: MEH [1994]) may make a substantial contribution to both aspects of competitiveness.[4] Accordingly, research and development and knowledge (technology) transfer may lead to substantial improvement both of the cost side aspect and of the quality aspect of competition.

Figure 1. Innovation from the aspect of a company: investment



Source: OECD [1995], p. 59

It should be noted that an enterprise may embark on a path of improving competitiveness through innovation only if such investments are promising to pay back and be profitable (accordingly, an entity assumes the risk inherent in market and technological uncertainty, in the hope of generating a future profit flow).

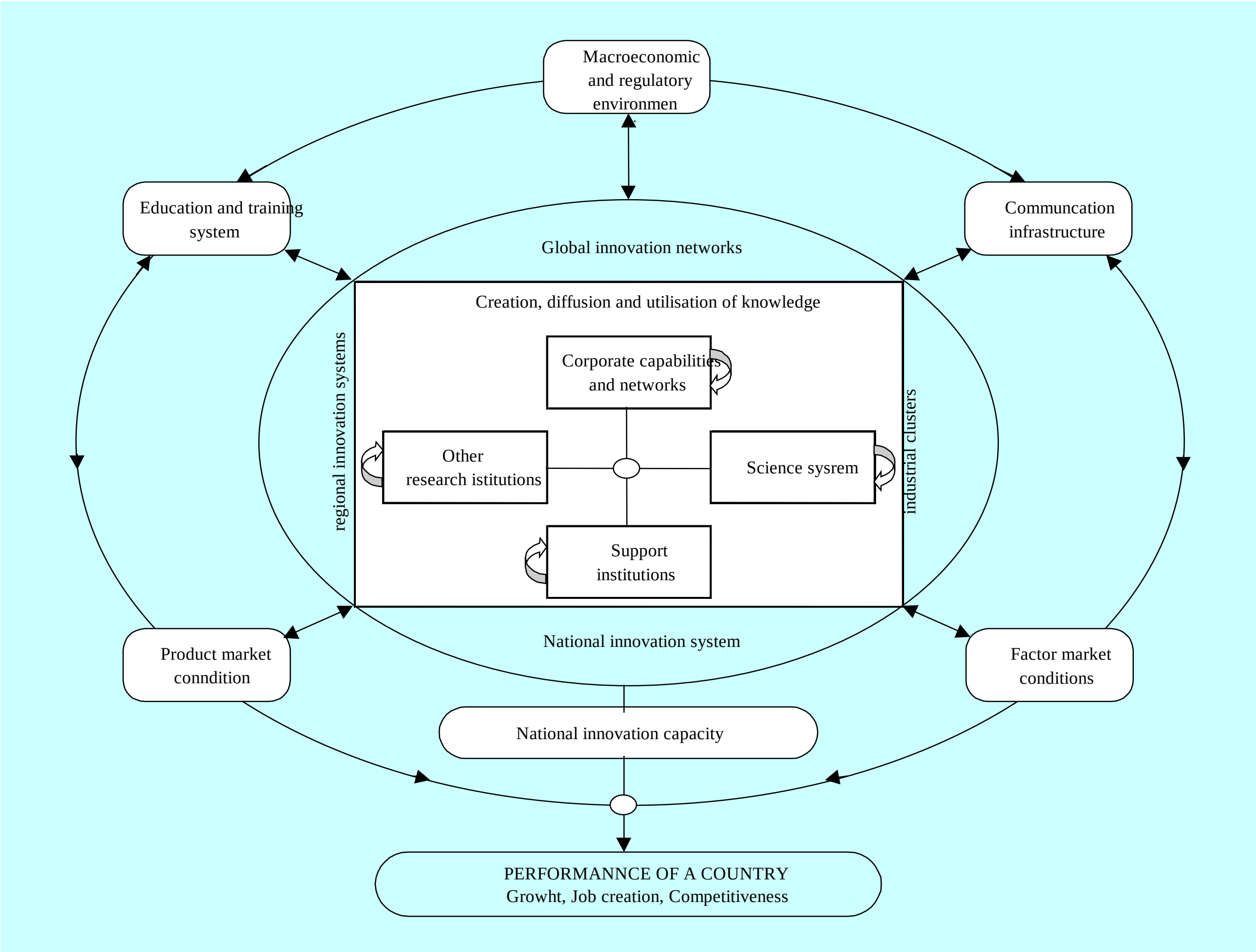
According to international research (e.g.: OECD [1997/a], [1998/a], [1999/a]) an enterprise implementing innovation (according to its definition applied by the OECD) is an inseparable element of the so-called innovation system. The 'national

3 Porter must not be disregarded in an analysis of what competitiveness means for Porter [1980], and Porter [1990] are perhaps the most influential pieces of work in modern competitiveness research.

4 Papanek [1999] for instance describes the 'link in the chain' model of the creation and spreading of innovation, as promoted by the OECD as well.

innovation system (NIS) concept became a focal element of research in the early nineties (Lundvall [1992], Nelson [1993]) and its underlying factor is how the quantity and quality of the links and relationships among the elements of the 'national' system generating innovation definitely influence the development of competitiveness. Knowledge flows play an outstanding role in these processes, in line with the spirit of 'evolutionary' economics. For example, it was specifically emphasised by OECD [1997/a, 1999/a], that the unimpeded flow of knowledge among companies, universities and R&D institutions is a fundamental guarantee of the smooth operation of the innovation system. For instance, joint research involving enterprises and research organisations, cooperation between the public and the private sector as well as technology diffusion and the mobility of human resources constitute the most important mechanisms of knowledge flow leading to competitiveness improvement.[5]

Figure 2. The factors influencing the innovation system and their relationships



Source: OECD [1998] p. 62

5 The importance of the increased scientific interest in the NIS framework is also confirmed by the so-called 'triple helix' concept which applies a similar approach, but which is a concept more of an American inspiration (Etzkowitz–Leydesdorff [1997]).

The innovation system concept unites various macro- (e.g. regulatory) and micro-economic factors (e.g. research and development) for a single purpose, that is the improvement of the 'competitiveness of the national economy' (welfare).[6]

The following is a review of the features of the Hungarian innovation system relating to research and development, innovation and technological modernisation of importance from the aspect of strategy development. The Hungarian data will be compared first to those of the Visegrád Countries (Czech Republic, Poland, Slovakia, Slovenia) and some smaller economies of the European Union (Austria, Belgium, Greece, Ireland, Portugal) and the micro-economic factors will be presented on the basis of empirical research findings.

2. Some of the main features of the Hungarian innovation system

2.1. Macroeconomic aspects

The research and development (R&D) potential of a country is often expressed in terms of the R&D expenditure. According to absolute R&D expenditure (calculated at purchasing power parity) Hungary takes one of the last positions with one of the smallest amounts among OECD countries.[7] A similar picture is yielded by a review of the expenditure per researcher or per citizen. Nevertheless, in the majority cases GDP proportionate R&D expenditure figures are taken into account for the comparison of countries. In terms of Hungary's regional competitors, the Hungarian, Polish and Slovakian ratios that are closer to 1.0 % are very substantially smaller than the corresponding figures of the Czech Republic and Slovenia, which are closer to 1.5 %. Advanced economies of the EU (Austria, Belgium), similar to Hungary in terms of population, will soon exceed 2.0 % while Ireland seems to have got stuck below 1.5 %. The corresponding figures of Portugal and Greece, countries usually regarded as less advanced Member States, are similar to those of Hungary, although they feature more favourable dynamics.

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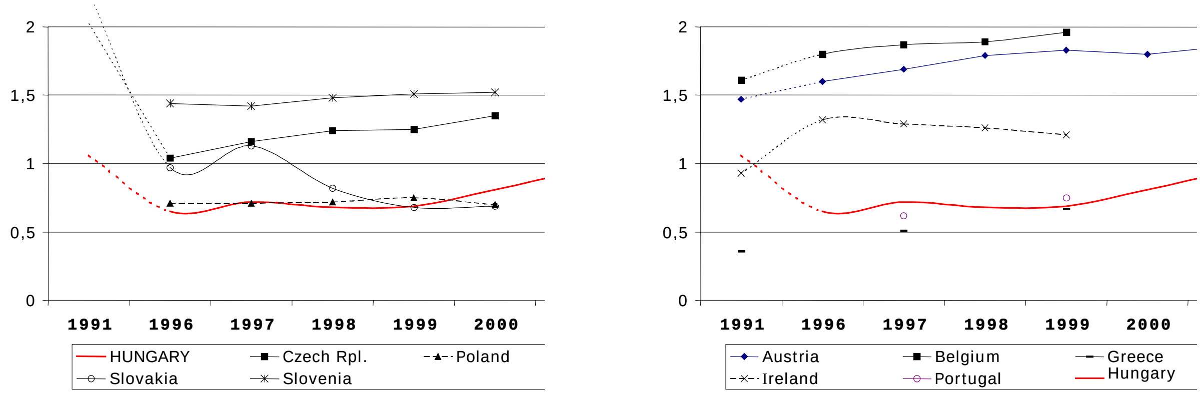
6 It should be noted that instead of the regularities of 'classic' economics - based on scarce resources and choices to be made between them - a national innovation system will be dominated by the performance of the enterprises selected by 'evolution' through the intensification of 'knowledge flow'.

7 The statistics of gross domestic R&D expenditures (GERD), in terms of ECU purchasing power, of relevance beyond the group of the OECD countries , are available in a paper published by the European Union in 1997 (EC [1997]). Hungary is 43rd among the 50 countries covered by the paper, accordingly, Hungary is one of the countries spending the smallest amounts on R&D.

Figure 3. Research and development expenditures (GERD) as percentage of GDP*



*Gross Domestic Expenditure on R&D

Source: OECD [MSTI 2002]

The generally low level of Hungarian research and development expenditures is indicative of a substantial shortage of funds in the research and development sub-system of the innovation system.[8]

The business sector has a 43% share worldwide within the national R&D expenditures[9]. The latest Hungarian statistic is somewhat higher (2001, 40.1 %), whereby Hungary is in the 29th position among nations. It should be noted, however, that the business sector in advanced countries accounts for over 50 % of the research and development expenditures and Hungarian researchers have not reached this range since 1991. From among the regional competitors the Czech Republic and Slovenia are reliably up to the 50 % threshold, though Poland and Slovakia are below this level.

The group of Hungary, Poland and Slovakia shows a weaker performance in terms of the GDP proportionate R&D expenditures as well, and comparison to the EU countries covered by our review also shows similar results to those of the total R&D expenditures.

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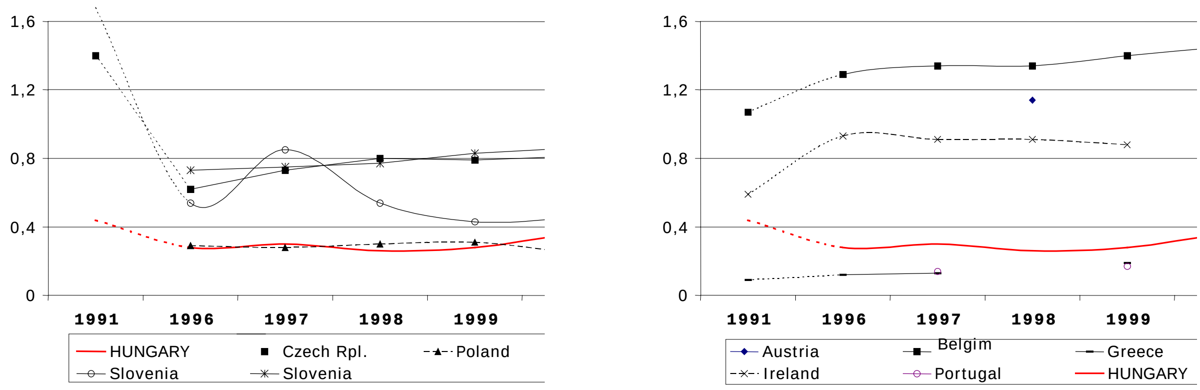
8 Note: this piece of information reveals nothing about the innovative effectiveness of the research and development sector!

9 Not weighted average. If only the 50 countries for which the GERD is available are taken into account and the share of the BERD is weighted with the GERD values, the ratio is actually 69 %.

Figure 4. The R&D expenditure of the business sector (BERD) as a percentage of GDP*



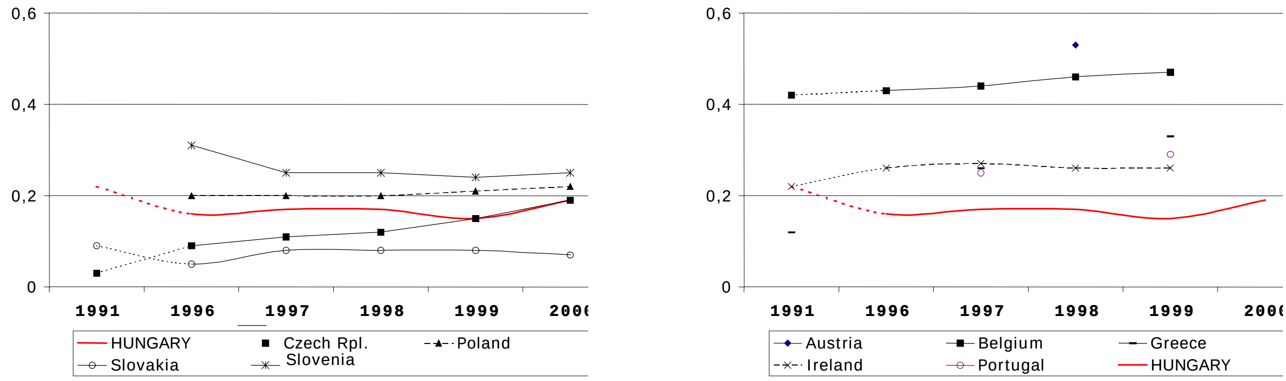
*Business Enterprise Expenditure on R&D

Source: OECD [MSTI 2002]

According to official statistics[10] R&D expenditure of the business sector falls below even the total R&D spending. This is one of the major obstacles to the competitiveness boosting mechanism of the innovation system (another important factor is, however, the way the business sector spends funds on R&D. The most important obstacles to competitiveness will be discussed in the next point in which empirical data will also be presented).

Since higher education is the third large sector implementing R&D, it is also worth looking at the R&D expenditures of this sector, as a % of GDP.

Figure 5 R&D expenditure of the higher education sector (HERD) as a percentage of GDP*



*Higher Education Expenditure on R&D, comprising funds spent on R&D in the higher education sector.

Source: OECD [MSTI 2002]

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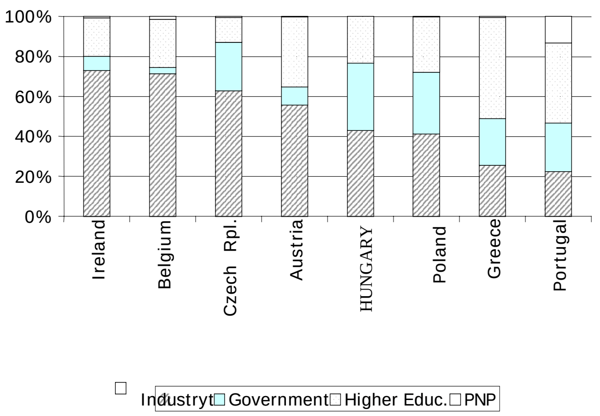
10 Papanek [1999] already drew attention to the fact that the statistics collected on the innovation activities of enterprises (including R&D) is probably far from what could be considered as complete.

From among Hungary's regional competitors Slovakia is falling back with its ratio below 0.1 %, the majority of the other countries concerned show figures around 0.2 % (albeit the Hungarian and particularly the Czech figures show improving dynamic). At the same time expenditure on R&D - relative to GDP - is way below even the corresponding figures of the least advanced EU countries, while the difference in comparison to the most advanced ones seems impossible to make up, in a short run. **Accordingly, spending on R&D in the higher education sector, as a percentage of GDP, does not seem to be sufficient either, for the sector to make any major contribution t the improvement of the competitiveness of the innovation system.**

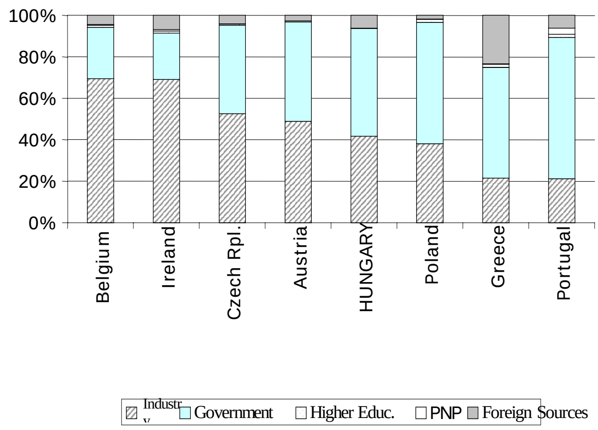
Unfortunately, the financial data on R&D also cover a variety of structural disorders. More than half of the total R&D expenditure in Hungary originates form the government (about a fifth of which is utilised by the network of institutions of the Hungarian Academy of Sciences, employing a mere 8 % of the total number of people employed in R&D). The business sector ('industry'[11]) is funding its own research efforts in essence while governmental R&D expenditures are used for the financing of state-owned research organisations (56 % governmental, 39% in higher education), and applied research and experimental development account for a small percentage of the total expenditure on R&D (see Annex). In comparison: in Belgium 22 % of governmental R&D expenditure supports industry while the corresponding figure in Austria is 11 % and it is close to 20 % in both the Czech Republic and Poland. **The ratio of about 5 % observed in Hungary is not worthy of the traditions of industrial research in Hungary.**

Figure 6. Sectors carrying out R&D and sources of funding

IMPLEMENTING



FINANCING



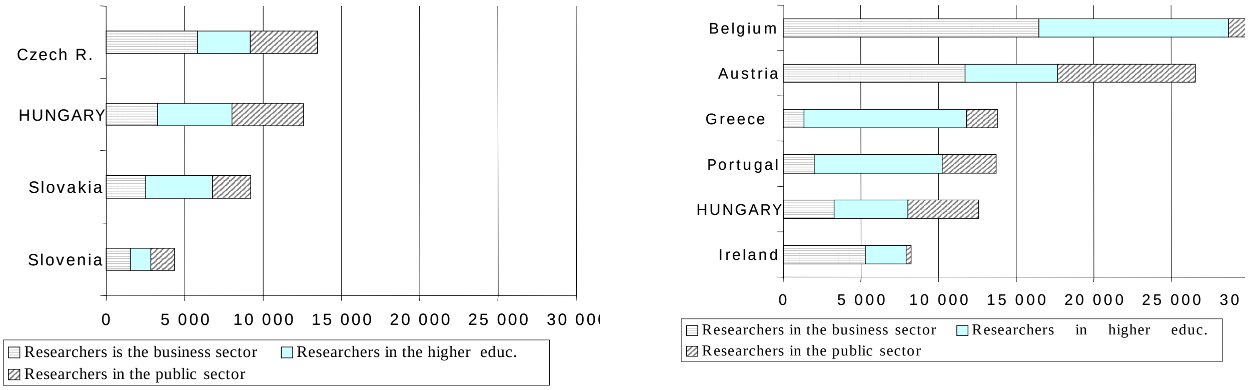
Source: Own calculations based on OECD [BSTS 2000]

Almost 4 persons (3.7) in 1000 employees are working in R&D in Hungary. Among the OECD countries this ratio is lower only in Slovakia (3.3), Italy (2.9) and

11 The Hungarian equivalent of the word is used in the study in the same sense as the English word, i.e. including services as well.

Turkey (0.9), while the Polish figure is the same as the Hungarian. The corresponding figures of Belgium, Ireland and Austria are 7.8, 5.1 and 4.7. Besides the small number of persons working in R&D their structural distribution is also indicative of a major deficiency: there is a low ratio of people working in R&D in the business sector in comparison to the total number of researchers.

Figure 7. Number of employees in R&D (standardised on a full time basis)

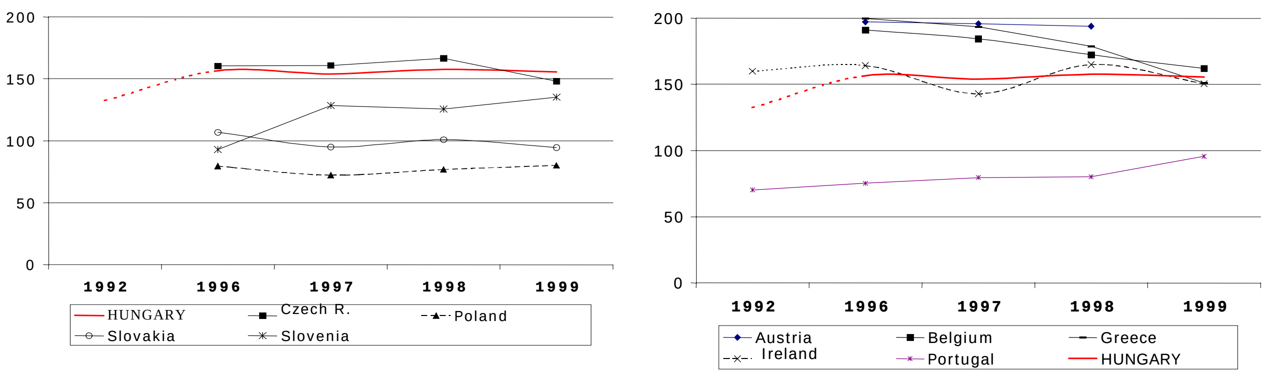


Source: *OECD* [MSTI 2002]

The number of researchers working in the public sector is similar in the Czech Republic and Hungary, however, the number of researchers working in higher education is only about two thirds of the number of Hungarians working in the same sector while the number of researchers working in the business sector is almost twice (1.8) times as large as in Hungary. In general, **the more advanced a country is, the larger the share of the researchers of the business sector will be within the total number of researchers.**

In addition to structural problems Hungary is also influenced by the so-called European paradox, according to which no matter how balanced a 'scientific' performance Europe may show (as is indicated for instance in the high number of the holders of PhD degrees or the publication performance), if it is capable of innovation or of utilising scientific achievements in practice only to a modest extent.

Figure 8. Publications per 1,000 researchers

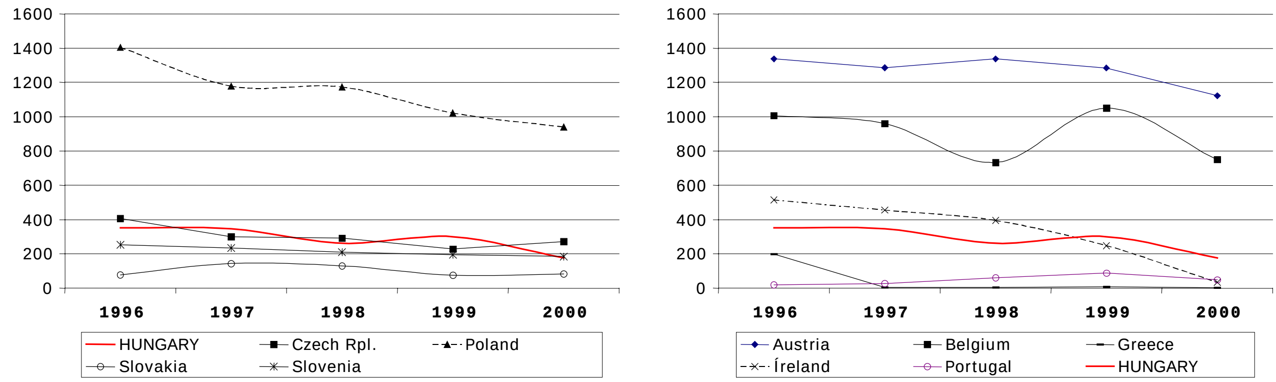


Source: own calculations on the basis of National Science Foundation (www.nsf.gov) and OECD [MSTI 2002]

For example, Hungary delivers the largest number of publications per 1,000 researchers within the group of Visegrád countries (in close competition with the Czech and Slovenian researchers); both Poland and Slovakia are way below the level of 150. This publication output of the Hungarian R&D sector is, by the way, comparable to the EU Member States covered by our review.[12]

At the same time, in contrast to performance in terms of publications, the number of patents is an acceptable indicator of the innovation performance as well (for publications measure 'only' scientific performance).[13] Statistics show that the balanced Slovenian indicator has overtaken the Hungarian figure just as the Czech ratio, which is not deteriorating as fast as does the Hungarian indicator. Slovakia has always been somewhat below the Hungarian figure. The same applies to Ireland, with the exception of the period between 1995 and 1998. The Austrian and Belgian figures are also declining only at a much higher level (to be compared to the slowly improving performance in terms of publications).

Figure 9. Development of the number of domestic patents



Source: World Intellectual Property Organisation (www.wipo.org) statistics

A look at the development of the number of patents relative to the number of researchers will show a similar decline of Hungarian data in terms of the number of patents/1,000 researchers, as in the case of the previous ratio.[14]

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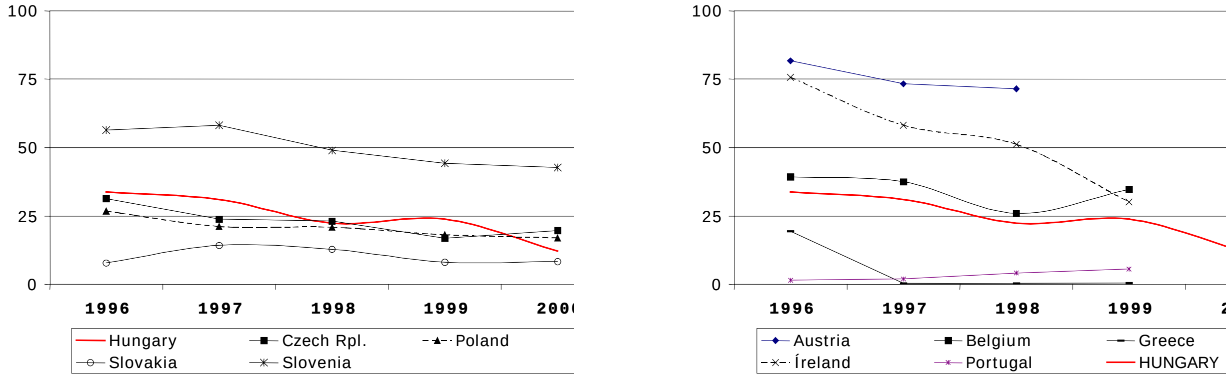
12 1,000 Hungarian researchers publish some 155 cited scientific publications a year, placing Hungary 19th among all countries of the world. By the way, the publication output of Belgian, Greek and finish researchers has deteriorated considerably to the level recorded in the mid nineties, while the Chilean, German and Czech statistics show stagnation similarly to the Hungarian figures. The Irish figures are also similar to the Hungarian figures 'converging towards it in an oscillating pattern'. Norway has shown a lower performance since 1996 in respect of this indicator. Since 1997 the publication activities of US researchers have also dropped below those of Hungarian researchers.

13 In terms of the trends of the statistics on patents registered in 2000 in Hungary it is to be noted that in year 2000 Hungary took the 32nd place in the global ranking of countries in terms of the number of patents (compare to the 19th position in terms of the number of publications). It should also be noted that the number of patents approved in Hungary is in close correlation to the number of patents registered in the USA, though the first ratio is available on a larger number of countries (the correlation coefficient is 0.93).

14 The ranking order in terms of this important indicator of researchers' effectiveness - excluding Monaco, which reported of 954 patents per one thousand researchers in 1998 - is lead by South Korea

Figure 10 development of the number of domestic patents per 1,000 researchers

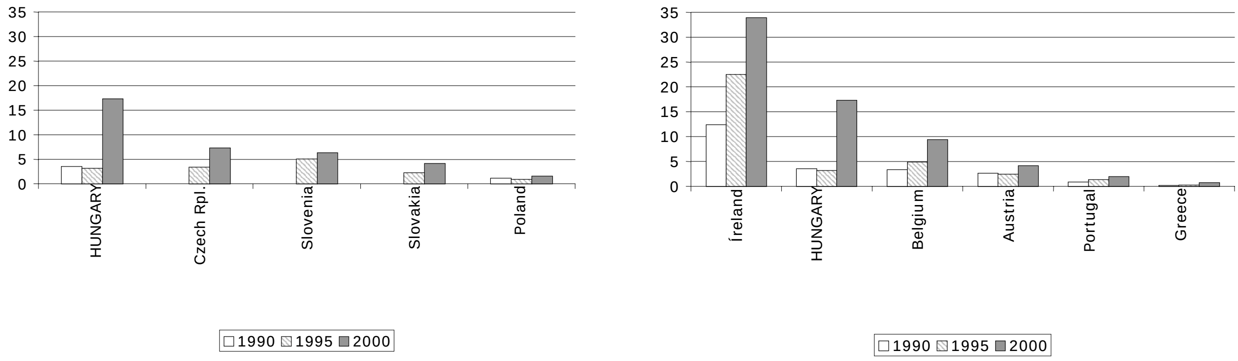


Source: Own calculations based on World Intellectual Property Organisation (www.wipo.org) statistics and OECD [MSTI 2002]

The figures show that **the performance of Hungary in terms of both the absolute and the relative (per 1,000 researcher) number of patents has been declining in recent years** (a longer time series is presented in the Annex). At a macro-level this ratio shows most saliently the crisis of the Hungarian innovation system.

Of course, in principle, on the basis of high technology exports relative to GDP, it might be argued that there is nothing wrong with Hungary's innovation system and the economy of Hungary is competitive. However, the ratio of high technology exports relative to GDP is a special indicator. It may be just as high in small but rich countries as it may be in poorer countries with larger populations, specialising on high technology industries. In respect of this ratio Hungary (with its 17%) took the respectable 9th position in global ranking order in 2000. Hungary was preceded only by Singapore, Malaysia, Malta, the Philippines, Ireland, Taiwan, Estonia (22%!) and Thailand: a group of countries including both poor and advanced countries.

Figure 11. High-tech exports as a percentage of GDP



Source: Own calculations on the basis of UNCTAD statistics

with a figure over 200. There are only three more countries reporting figures over 100: Japan (173), Moldavia (146) and Kasachstan (100).

In our case the **high ratio of high-tech exports is a misleading ratio concerning the innovation system.** For although the exports of such products may be the key output of competitive (technical) R&D in the case of a small country with an open economy - such as Hungary - and one may be easily misled by the fact that the Hungarian industry is capable of reaching 57 % of the high-tech exports of a European economy (Finland, see for instance OECD [1999]) which is considered to be one of the most competitive economies in Europe, yet one should be careful in making judgements from such statistics for in contrast to Finland **there are very few links between Hungarian R&D and the Hungarian high-tech exports** since the majority of such exported products originate from companies in foreign ownership which make precious little contribution to the domestic R&D expenditures.[15] (The fact that high-tech exports are no longer related very closely to the domestic R&D processes is best indicated by the observation that the - evidently export-oriented - pharmaceutical industry accounting for almost half of the total R&D output of the business sector had a mere 4.3 % share of the total domestic high-tech exports in year 2000). Moreover, the closure of a single company (IBM, Philips, etc.) can substantially reduce the otherwise really favourable Hungarian high-tech export position from one year to another.

From among the statistics providing a macro-level insight in the innovation system the **features of the info-communication infrastructure are not indicative of any rapid improvement of the competitiveness of the economy of Hungary in a short run either.** In the group of countries reviewed only Poland shows lower ratios in terms of the number of mobile phones or Internet users per capita. The only promising figure is the volume of investments in the telecommunication sector in terms of USD per capita over the recent 5-year period,[16] though the corresponding Czech figure is also much higher.

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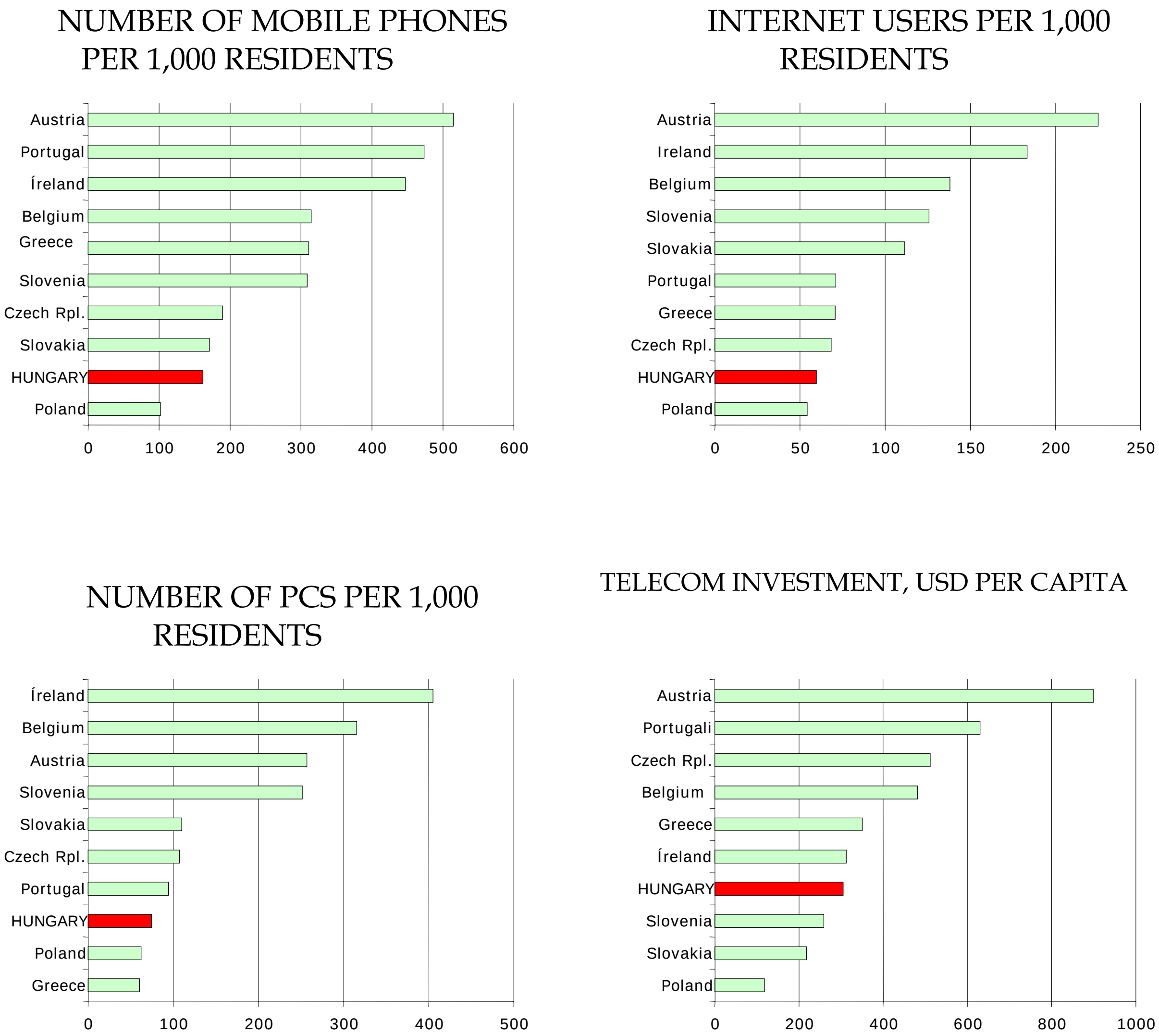
15 IBM was typical example of such companies. At the same time there are exceptions as well, one of the most important such companies is Ericsson Kft. It should also be noted that the foreign entities pursuing intensive R&D operations in Hungary do not support the Hungarian industry, instead, they supply cheap competitive R&D ‘knowledge’ to their foreign parent companies, in the majority of cases. Accordingly, such companies have marginal R&D savings effects.

16 Particularly, if the substantial investments of the preceding period are also taken into account. See, for instance, Diczházi [1998]; OECD [2002/b].

Figure 12. Certain indicators of the info-communication infrastructure (2000)



Between 1996 and 2000,

Source: UNCTAD statistics and own calculations based on them.

Apart from a few exceptions it is no longer possible to show macro-indicators of the innovation system (that are also related to innovation), which would not reflect deterioration of the situation. According to statistics the Hungarian innovation system is far from being sufficiently innovative. This is probably partly a result of the fact that except for a few symbolic gestures the state is a rather passive participant of the processes of innovation. The fact that the **state does not fulfil its role in promoting innovation as would be required for catching up and for the improvement of competitiveness** is a result - inter alia - of the following:

– since year 2000 only a deputy state secretariat is in charge of matters pertaining to innovation (beforehand the National Technical Development Committee /OMFB/ had a rank equalling that of a ministry, similarly to the ministerial ranking of the Central Statistics Office);

- there has never been such a thing as 'Hungarian innovation policy' (on this matter see Szentgyörgyi [2003]), the closest thing was a R&D policy that had been trying to facilitate linear 'technology push' which had been outdated already before the system change, and has never really focusing on 'industry'. This state of affairs had been criticised both by the OECD [1998] (p. 31) and by the EU [2003/a] (p. xiv);
- almost the whole of the governmental funding of R&D is spent without taxpayers ever knowing about the impacts on industry (the economy);[17]
- institution financing practices without demanding adequate performance are very wide spread, as are the spending of funds through application schemes, without ever being actually utilised;
- 'real' innovation processes are not measured by the Central Statistics Office (KSH) on a regular basis, despite the fact that for instance the IKU-Innovation Research Centre of BKÁE (Budapest University of Economic Sciences and Public Administration) is already proven to be capable of the application of the EU Community Innovation Survey (some periodical publications do appear, though, e.g. KSH [2001]);
- the state does not take the protection of intellectual property rights seriously enough, despite the fact that after measures taken by the United States of America this issue is now also treated as a priority area by the European Union. Attention has been drawn to the necessity of prioritising this field by Papanek [1999] on several occasions. 'The strength of the protection of intellectual property is perhaps the most fundamental one of the policies determining the national innovation capacity for this is the factor that ensures adequate rewarding of inventors … '(Porter–Stern [1999] page 27).

The well-known **macro level risk factors** also rely on the strategic aspects outlined above:

- there are concerns that 'politics' will, for long years to come, continue to fail to realise that it needs to 'think in terms of an innovation system' if it is to accomplish any substantial improvement of competitiveness. That is, the sub-systems of government will, for quite some time, continue to be unable to coordinate the various functional sectoral policies with innovation mechanisms;
- a significant part of the lobby groups having interests in 'science' (numerous research units of the Academy, university research units etc.) will, for quite some time to come, fail to coordinate their activities with the innovation requirements of 'industry' and the society as a whole; [18]

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17 The findings of the 'First comprehensive project evaluation attempt' („Az első átfogó projektértékelési kísérlet") (Török [1997/b]) are probably known by few, and even the mere concept of 'having to evaluate' must have been rather unpopular.

18 Balázs [1998], for instance, has been severely criticising the existing system of the Academy for quite some time. The basis of his criticism is that the 'honorary' scientific and the real research roles and functions are not separated within the system of the Hungarian Academy of Sciences. According to Balázs the honorary participants and those supporting industry should be separated- as it is in the

- effective protection of intellectual protection cannot be created overnight either. As long as the society looks upon forms of behaviour breaching the law and morals[19] in a lenient way (if not actually keeping fingers crossed for those violating the law), we may not really hope for innovations that may be widely introduced (detailed descriptions of the phenomenon are supplied by Papanek [1999/b]).
- The innovative adaptability of the economy of Hungary and its catching up in terms of competitiveness, depends on a variety of demand sand supply side frame conditions that may provide for smoother operation of the innovation system primarily through the enhancement of 'knowledge flows':
- on the supply side the target should be for the R&D sector operating with public moneys to produce new knowledge primarily and directly for the economy (technical/technological innovation) and to a lesser extent and in a more indirect way for the society (medicine, welfare);
- on the demand side companies should be prompted to acquire 'new knowledge' from the professional research and development sector and the business sector itself should also be prompted to be engaged in more intensive 'research activities'. At the same time in some cases the state may also appear on the demand side as a collective technology buyer entity;
- in terms of the frame conditions catching up will depend on the extent to which the state is capable of facilitating the diffusion of the output of the research and development sector, of 'producing' and retaining high quality 'knowledge manufacturers' that are affordable for the economy and of concentrating innovative excellence to the justified extent.

The proposed measures are discussed in detail in section 3.

2.2. Factors influencing the innovative competitiveness of the micro-sector

Despite the rather unfavourable macroeconomic situation there are innovative segments in the economy of Hungary, though the above statements are, on the whole, confirmed by the most important empirical research findings as well.[20] The

case of the Czech system - the latte should be transformed into national R&D laboratories. At present the HAS holds ownership rights and guaranteed state subsidies, indeed, the Academy has a say in the formulation of science policies as well. The result is a confused system of responsibilities without providing adequate motives concerning innovation.

19 This phenomenon - though it must be the tip of the iceberg - is clearly indicated by the practices of tax avoidance, 'private public' tenders, enjoyment goods purchased for private consumption and charged to the business etc.

20 For example: the first postal survey data on the manufacturing industry were published by IKU – Innovation Research Centre (Inzelt [1995]) and IKU made the first attempts to measure innovations in some service providing branches as well (Inzelt [2001]). A survey aimed at a comprehensive assessment of the micro-economic factors of the Hungarian innovation system was undertaken by Papanek [1999]. In year 2001 the Central Statistics Office (KSH [2001]) carried out a representative

following is a description of the features of the innovation system on which we have empirical survey data (from companies and research units).

There are marked links, relationships and regularities underlying the competitiveness, product innovations and technological processes of Hungarian manufacturing companies. The following has been revealed by a total of 272 responses from the manufacturing industry recorded in the course of a research project carried out last year (Borsi [2003])[21]:

- businesses introducing new products are more likely to introduce new technologies;
- the introduction of new technologies has a positive impact on competitiveness: almost two thirds of respondents introduced new technologies last year and the overwhelming majority of such entities have products that are competitive in the EU markets as well;
- two thirds of companies with competitive products introduced new technologies during the preceding three years;
- there are very few companies in the manufacturing sector (about 16 %) that did not introduce any new technology or product during the three years preceding the survey. Fortunately, a larger percentage of these entities (11 % of all manufacturing firms) are capable of turning out products considered competitive in the European Union as well (most of them low priced products).

Table 1. Entities reporting of introduction of new technologies and new products, those indicating competitive products (%)

New products	*Products that are competitive in the EU*	*New technology introduced?*		*Total*
		Yes	No	
been introduced	does have	45	17	63
	does not have	7	2	9
not been introduced be	does have	10	11	21
	does not have	3	5	8
Total		65	35	100

survey on the manufacturing industry (involving 291 respondents). Very important surveys though not on a nationwide scale were carried out by Dévai et al. [2000] on relationships between industries and universities, by Dőry-Rechnitzer [2000] on the regional innovation systems and Viszt et al. [2000] on the mobility characteristics of innovative human resources.

21 GKI Rt. provided valuable methodology assistance to the survey. The responses received may be considered as representative of the manufacturing sector: in the course of the research a total of 516 Hungarian manufacturing firms employing more than 5 employees received questionnaires and the 272 questionnaires returned equal a 52 % response rate. The survey accessed 1.8 % of the target group of companies. The rate of representation was higher in the group of larger entities (6.3 %).

Source: *Borsi* [2003], survey (autumn of 2002)

In respect of the Hungarian manufacturing industry, therefore, the theoretical links between innovativeness, technology adaptation capability and competitiveness do exist in practice as well. At the same time, the processes of technology introduction, and the innovation processes differ between groups of companies and between different types of markets as well. There are a substantially smaller proportion of entities among small businesses that are ready to introduce new technologies or new products and almost half of small businesses were not capable of introducing technologies or new products during the three years preceding the survey.

Table 2. Share of manufacturing firms that had introduced new products to the market during the 3 years preceding the research (%)

New product	*New technology*	*Small*	*Medium sized*	*Larae*	*Total*
		enterprises			
introduced	introduced	44	56	63	54
	did not introduce	20	17	17	18
did not introduce	introduced	12	13	10	12
	did not introduce	24	14	10	16
Total		100	100	100	100

Source: *Borsi* [2003], survey (autumn 2002)

About 16 % of the Hungarian manufacturing firms (44 businesses) were not innovative at all, they introduced neither technologies nor new products during the three years preceding the survey (it should be noted that the above ratios are still somewhat more favourable than those reported by the Central Statistics Office, (KSH [2001])). Although a substantial percentage of these entities have products (services) considered as competitive in the EU markets as well, their future is rather uncertain on the threshold of Hungary's EU accession.

A question already touched on in the chapter describing terms and concepts, i.e. which are the most important factors of competitiveness in the manufacturing sector, or which competitiveness factors are promoted by the above technological/innovation processes, is to be dealt with here. The opinions of the entities involved in the survey seem to be highly uniform: they consider that the majority (over two thirds) of the products and services of the Hungarian manufacturing industry are competitive because they are cheap. Accordingly, companies are making efforts to achieve cost side competitiveness through technological processes. Of course, there is a group of companies that consider their products expensive and high quality. This appraisal, however, should be taken with a pinch of salt, for according to several case studies (contained in the MISZ [2002]) that are suitable for the extraction of more in-depth information, a number of companies, whose products qualify as expensive in the Hungarian market, consider that they products are in fact cheap. This applies in particular to companies manufacturing and exporting products that qualify as expensive in the domestic market.[22]

Table 3. Why is the product/service competitive (percentage of respondents)

	Small	Medium sized	Large	Total
	businesses			
Expensive and high quality	16	15	22	16
Cheap and high quality	55	56	63	55
Cheaper than that of competitors	31	26	29	28
Has good sales channels	5	7	8	6
Good advertisement	0	2	2	1
Supply their parent companies	11	13	15	13

Source: *Borsi* [2003], survey (autumn 2002)

Though factors of competitiveness do not differ materially by the size of businesses, however, some matters of detail could be observed from the large number of responses received. Larger companies possess expensive and high quality products in most of the cases, although cost competition is also most intensive in this group of companies. From a technological angle Pandurics [1997] (p. 15) points out that more than 40 % of industrial companies use programs that are suitable for the reduction of the change-over time of the machinery (and an additional 22 % of them will make efforts so use such in the future).

In respect of the improvement of competitiveness by innovation we may also rely on technical literature. Gittleman–Wolff [1995], for instance, explains that own R&D efforts will be effective primarily in the case of the companies that represent the cutting edge in technical standards as well; otherwise the processes of innovation should be concentrating on the adoption of existing knowledge. According to Cohen–Levinthal [1990] in the emerging economies - including Hungary - research and development should be focused on enhancing the capability of adaptation and adoption instead of extending production capabilities. Accordingly, the most appropriate direction of development should be to ensure, on the one hand, the integration of the largest possible proportion of (still) existing Hungarian R&D capacities in the economic processes, and on the other hand, to promote research that will facilitate this process: i.e. the Hungarian R&D sector should become strongly business oriented. However, as long as the Hungarian businesses consider that they cannot hope for innovation support from domestic R&D institutions, we see little chance of this happening.

22 It is easy to check by gleaning through prices of Hungarian products available in West Europe. Pick salami and Tokaji aszú, which belong to the higher priced products in Hungary, are medium priced products - at best - on the shelves of shops in France or Germany.

Table 4. The percentage of businesses expecting material innovation support from the institutions listed below (%)

Institution	*- 50*	*51 - 300*	*301 -*	*Total*
	headcount of business			
University, college a) in the region	12	9	15	11
b) elsewhere	8	10	15	10
Domestic R&D institution	10	12	13	11
Domestic information institution	18	20	24	20
Inventions Office	4	3	4	4
Other domestic enterprise	27	29	19	26
Foreign parent company	12	17	19	15
Other foreign organisation	8	10	10	9

Source: Survey carried out by GKI Rt. in the spring of 2001, reported by: *Papanek* [2003], p. 10.

Why can the enterprises not count on the R&D sector? One of the reasons must be that the domestic research and development institutions are not thinking in terms of innovation in the management of their research 'projects'. The majority of the R&D institutions publish the results of their research programmes; most of them also use research output in education as well (Borsi–Papanek [2002]). This is indicative of a dislike of research 'destined to be tucked away in archives' at the majority of research organisations.

Table 5. The percentages of research units transferring their research results in the ways listed in the table (%)

Mode of knowledge transfer	*University*	*Academy*	*Business*	*Total*
	research unit			
Patent etc. sale	17	18	57	20
Studies for the public sector	42	46	36	43
Studies for businesses	39	39	64	41
Studies for international organisations	19	29	14	21
Sale of new products, services	12	14	57	17
Sale of machinery, equipment	6	14	36	11
Publications, presentations at conferences	90	89	71	88
Education	62	50	43	58

Source: *Borsi–Papanek* [2002] p. 48. Survey was carried out by a consortium of BME-GKI, for the Ministry of Education, interviewing 180 Hungarian research units.

In analysing the figures presented in the above table attention needs to be paid to the expectations imposed by the EU on the R&D sector as well. The terms and conditions of the No. 6 Frame Programme of a total of EUR 17 billion, launched last November, lay special emphasis on the importance of research results and output that can be utilised in the market in the form of patents, products and services. R&D results are provided with protection through patents in the case of less than a quarter of institutions (most often in the fields of natural sciences instead of technical sciences) and in many cases (particularly in the case of institutions belonging to the Academy) they are rarely presented to and even less frequently utilised by enterprises. In less than a fifth of Hungarian research organisations are research results integrated in products or services and only exceptionally are they utilised in the development of machines and equipment. Materially more favourable ratio were reported primarily by some institutions in private ownership (of businesses), primarily in respect of a much higher ratio of patent coverage and a much wider range of appearance of research results in new products and technologies). Unfortunately, according to the findings of the research - in addition to education and publication - the majority of research results are utilised in the forms of 'studies' and the R&D sector is assumed to have no substantial information on further utilisation of the results of research.

The effects of technological modernisation on competitiveness have been mentioned already. It is also worth taking al look at the origins of technologies introduced by companies during the three years preceding the survey.

Table 6. The ratio of manufacturing firms designating the sources of technology among those that have introduced technologies (%)

	Small	*Medium sized*	*Large*	*Total*
	businesses			
Own development	65	56	51	57
Purchased from foreign company (other than parent)	25	35	42	34
Purchased from parent company	8	21	33	20
Foreign university/R&D institution helped in adaptation	0	0	0	0
Purchased from domestic company	24	16	7	16
Domestic university/R&D institution helped in adaptation	2	4	7	4
Other source	2	0	0	1
Average number of sources of technologies	1,25	1,33	1,40	1,32

Source: *Borsi* [2003] survey (autumn 2002)

A very large proportion of manufacturing firms rely on their own development efforts in the introduction of new technologies, which is obviously a factor reducing efficiency (see the above reference to Gittleman–Wolff [1995] above) It should also be noted that about twice as many entities purchased new technologies from foreign companies than from domestic ones (though the indicated share of domestic firms in technology purchase is not low. It may be assumed, however, that in a number of cases the assts of other businesses - some of them gone bankrupt - were purchased or otherwise acquired (e.g. through in kind contribution) by other businesses.) The proportions of own development, domestic businesses and entities abroad, as sources of technologies, varies in an interesting pattern among businesses from the aspect of size. Small businesses are more reliant in the case of the introduction of production technologies on their own development or on domestic businesses than on foreign entities. Large companies are more inclined to purchase technology from abroad, though in their case the domestic R&D sector also plays some role, even if that role is not in line with the scientific prestige of the sector (7 % of large enterprises used the services of domestic R&D institutions during the three years preceding the survey).

The above data are also clearly indicative of the weakness of the so-called bridging institution system and the insular nature of relationships between industry and universities (industry and academia or even industry and science):

– companies do not expect material assistance from ‘networks’ aimed to promote innovation efforts, most of them financed by the state (such as the chambers, various foundations - see table 3);

– public research organisations (e.g. university departments, institutions of the Academia) do not ‘supply’ businesses (tables 4 and 5).

In addition to those mentioned with respect to macroeconomic factors the **state has numerous opportunities for having direct impacts on the micro-level innovation processes.** The most substantial progress is expected to be promoted perhaps by the act on innovation - its drafting is in progress - if a new piece of legislation that is in line with the concept of a national innovation system, coordinated with the demands of an innovative economy (see above), one that is really something of a ‘breakthrough’. As to what chances the introduction of such an act stands: attempts were made at the introduction of legal regulation on innovation already in the wake of the system change. In 1992 a draft act on technological research and innovation - the preparation of which involved a large number of experts - was proposed, even the relevant inter-departmental coordination efforts brought about positive results but eventually the draft was not submitted to the Government.[23] The intent is there even at present: the Government Programme announced in mid-May 2002 and the Medium Term Economic Policy Programme adopted in August referred to research and development and innovation as factors of central importance.[24] The effective implementation of the objectives requires legal

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23 The situation is characterised by the fact that the term research and development is not included at all in the act on the Academy (Act XL of 1994) and it is only mentioned twice in the act on higher education (Act LXXX of 1993). A separate act has been adopted on patents (Act XXXIII of 1995) but no separate act has been adopted on research and development or on innovation which is an even broader area with a much more substantial economic impact.

24 Laying special emphasis on the following areas: making Hungary even more attractive as a location for research and development; strengthening of the protection of intellectual property; enhancement of the innovation sources of small and medium-sized enterprises.

regulation and, even more importantly, political determination. Most Hungarian professionals have been convinced of the necessity of an act on innovation for years and its submission is included in the government's work plan for the second half of this year.

Pursuant to Article 7 of Act LXXXI of 1996 on corporate income tax and dividends tax 'Pre-tax profits are reduced by the direct costs of basic research, applied research and experimental development incurred during the tax year net of the amounts of subsidies and grants received for such activities and booked as revenues, along with the amounts of research and experimental development services provided by resident taxpayers, domestic branch units of foreign businesses or by individual entrepreneurs as specified by the provisions of the act on the personal income tax.' A 20 % tax base reduction was granted on R&D activities up to year 2001. From the entire R&D expenditure may be deducted from the tax base: 50 % as costs, the other 50 % may be deducted from the basis of the calculation of the tax on profit. This measure is aimed to increase the share of the business sector in the financing of the R&D sector. This form of benefit had to be altered because the previous form of benefit was not used by businesses (its rate was only 20 % and was available only in the case of 'in-house' research and development). Today this benefit is available even in the case of research and development services purchased from budgetary institutions.

3. Future objectives and possible measures

The key lesson drawn from the assessment of the situation is that the Hungarian innovation system is not functioning as a 'system'. By contrast, the EU takes the necessity of a systemic approach very seriously: at least the range of national economy indicators disclosed and analysed every year should be very convincing (see the annex or the latest publications (EC [2002], EC [2003/b])). Unfortunately, the current situation in Hungary in the field of innovation does not seem to be very encouraging: a multitude of factors should be altered at once if Hungary were to make a significant improvement but there is little chance of such an overall change:

a.) **Companies** should, first and foremost, recognise and accept the state of 'permanent competition' and they should be aware and should recognise the roles of the key micro-level factors of competitiveness (price, quality, advertisement, sales channels) in the development of the circumstances of competition. Technology procurements are, as a matter of course, aimed at reducing costs or improving quality in the majority of cases; in view of this fact companies should make attempts to 'make themselves understood' by the domestic R&D sector. To this end, business managers should be aware of the technical development trends of their own sectors, from trade fairs or exhibitions. Although development efforts may be coordinated by the managers of most small businesses without even having to use pen and paper, even such small entities are increasingly in need of a technology strategy (see for example Tidd–Bessant–Pavitt [2002]).

b.) **Scientists working in research and development** have to come to terms with the fact that R&D is to promote the growth of domestic added value and social welfare. The completion of demand-driven research will, of course, require 'market research', coordination, compromise, much hassle and the assumption of major risks, but it also offers a way out of the crisis of our R&D units without encouraging future visions. Economic improvement necessitates increased presence and activity of a hitherto well-nigh unknown type of scientist, the so-called 'entrepreneur scientist'. Such scientists may no longer afford to be disinterested in business negotiations or in intellectual property rights. Innovative performance and output has to be paid for and at the same time it should be accepted that the salaries of those who cannot work in accordance with the requirements of the up-to-date market economy would not increase (indeed, it will decline).

c.) Without active participation by the **government** it would be futile to hope for quick realisation of technological modernisation. The importance of education in line with the requirements of the economy is confirmed by research findings as well. The importance of an innovative, business friendly economic and legal environment has been proven by other surveys as well, as has the need for a radical transformation of the regime of R&D financing (involving increased role of project financing). Politics should be aware of the fact that in the circumstances of global competition R&D is the means of the exploitation of extra profits originating from monopoly positions. The state may play an outstanding role in influencing technology and knowledge flows if there is a real innovation (including R&D) strategy coordinated across the whole political spectrum. For this could ensure both a quicker process of technology adaptation and the practical utilisation of the domestic knowledge base, in an increasingly broader range.

It should be noted that some of the following concrete proposals are regulatory matters, not involving any expenditure (which is an important aspect under the current budgetary conditions). Of course in some cases financial contribution by the state would be necessary. The majority of solutions that need some funding from the budget may also be implemented through the rationalisation of arrangements.

Nevertheless, the EU objective, according to which the funding of research and development should be increased to 3 % of GDP by year 2010 in a system where two thirds of research and development originates from the business sector (not necessarily financing but implementing it), seems to be the task that will entail the largest financial input. It means that at current prices almost 4 billion Euros (3.7 - 3.8 billion) should be spent on research and development each year. By assuming stagnating (!) GDP and the current governmental R&D performance this requirement would mean that up to year 2010 the research and development activities of the business sector would have to be increased by some 30-40 % each year, consequently, it is almost certain that **Hungary will not be able to meet the requirement of 3 % as resolved in Barcelona.**

3.1. Steps to be taken on the demand side of innovation

Most progress towards meeting the 3 % (including the two thirds) requirement could, at any rate, be made through steps taken on the demand side (*EC* [2003/a] p. xi.). Within this approach the **so-called public technology procurement programmes** (hereinafter: PTP[25]) **programmes seem to be the most expedient arrangement**:

- areas of public health and public security seem to be in need of a wide variety of PTP programmes primarily but in fact the R&D component may be contemplated in respect of any public procurement programme with technical contents.[26] To this end, governments should be required to produce technology innovation plans on a regular basis, i.e. to specify the technological (innovation or R&D) contents of public procurements.
- US defence R&D expenditures have clearly demonstrated the need for 'smart' public procurement, for close cooperation between buyer and the supplier of innovation, for proper utilisation of development and for the expedient exploitation of spill-over effects.
- another US example[27] prompts European decision makers to refrain from excluding small and medium-sized enterprises from the majority of public procurement procedures.
- PTP may also result in the creation of so-called lead markets (those utilising innovation in the given market for the first time) and may also induce substantial spill-over effects.

As a matter of course, risk is part of PTP programmes - as it is of any innovation - the alleviation of which necessitates precise specification by the governmental buyer. The **involvement of the society of engineers in the resolving of governmental problems** is another risk-reducing factor and may contribute to the coordination of the solving of technological problems with other policies as well.

It may seem like a minor issue but the institution of tax credit on R&D does not exist in Hungary for the time being. Another similar problem is that institutions participating in European research programmes have to pay VAT on funds originating from Brussels and spent in Hungary - though their output is intellectual service export, in fact. Though the refunding of the whole amount of this may be claimed by entities not included in the range of VAT payers, yet the circumstances of this arrangement are completely unworthy of the entities concerned.[28] In the case of

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25 Public technology procurement

26 For instance, various types of asphalt are being developed in Austria in relation to motorway construction projects with 8-10 % lower noise emission in comparison to currently used asphalt materials. According to measurement results if industrial scale utilisation is resolved, noise emission may be reduced by 40-50 % on the whole.

27 Small Business Innovation Research program.

28 APEH accepts only translations authenticated by the organisation called OFI but an authentic translation may be produced only of an entire document; the OFI does not authenticate the summary

research organisations (owned by businesses) falling in the range of VAT payer entities the funding of the VAT constitutes an additional problem for the EU does not provide financing for that.

3.2. Supply side tasks

The funds spent on innovation (including R&D) through application schemes are best utilised if they facilitate the construction of (corporate) networks (e.g. industry-university relationships, industrial clusters). Another important recognition is (*EC* [2003/a] p. xi.), that non-repayable funds allocated through application schemes may provide the largest assistance during times of economic downturns: companies may reconstruct or at least retain their research and development capacities during times when otherwise they would have to cut costs.

R&D support policies do not have much influence on international R&D investment decisions, at the same time in less well developed regions - including Hungary - special attention needs to be paid even to the transfer of existing technologies. Clearly, this may be substantially promoted by the (international) research and development sector as well (fortunately, there have been quite a number of positive examples: GE, Ericsson, Nokia, Knorr-Bremse, to mention but a few of the most important ones).

The so-called contract research sector comprising entities competing for orders for research projects may play key role in the satisfaction of the research requirements of the traditional sector of small and medium-sized enterprises. The government has to make sure that this group of R&D entities[29] can maintain its scientific/technological expertise, indeed, it is worth providing assistance to such 'firms' for instance in their strategic research projects or in their industry-university type relationships.

The majority of domestic governmental R&D expenditures have, even since the system change, been utilised on the basis of the principles of normative institution financing. The annual budgets do not make it possible to see the objectives on which the government is spending research and development funds. The detrimental effects on innovation of the widely applied institution financing practices have become quite evident: declining, disintegrating domestic R&D sector, with the exception of some lucky entities that have found 'industrial' partners for themselves. Never has it been so evident before that a lot larger proportion of the available funds has to be devoted to performance oriented R&D financing, which may be secured by R&D entities through competition. Furthermore, state owned research organisations should also be permitted to accumulate capital.

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of a contract. It is not an easy task for anybody to find the 10-15 sentences in a 60-70 page EU contract that are to be translated for APEH to refund the VAT. The translation of the entire document would cost about HUF 200,000 - 300,000.

29 There are very few institutions in Hungary whose operations rely in research, selling their 'new knowledge' so developed, under competitive conditions. The promotion of such research forms is another task for the state.

The domestic research and development sector still includes a large number of units of sizes that are not competitive on an international plane. Concentration of university research units operating in many cases with no more than up to 5 researchers should also be promoted: all available means should be deployed to help research communities working on similar themes become parts of a small number of networks (or even of virtual communities). Lots of examples of such bottom-up efforts are known today. The government could encourage and promote these efforts, particularly where they involve industrial partners as well.

3.3. Providing the frame conditions

'Industrial' R&D investment may be promoted primarily by the frame conditions (in which for instance the effect of the enhancement of funds spent on R&D may play a dominant role only in a short run). The most important one of such frame conditions is the presence of highly trained researchers/engineers (in a 'critical mass') in the economy, who are capable of utilising their knowledge for the benefit of society. In respect of human resources the most important requirement is the promotion of external/internal mobility as well as of mobility between companies and the Academia (companies and universities). The two way international mobility of researchers - particularly that of young researchers - and their delegation abroad as well as the admission of young foreign researchers to Hungary for longer terms[30] (i.e. the acquiring of foreign knowledge) should be facilitated along with joint research and joint international publications of the highest scientific standards. No other approach could facilitate European integration as efficiently as this. In order to ensure Hungary's catching up both the state and the society should use their best efforts to activate the relationships and links of the innovation system (i.e. the flows of knowledge). The EU has committed itself to the organisation of the so-called centres of excellence in networks as well as their connection into the industrial processes (see *EC* [2000]).

A reassuring and long term arrangement should be provided for the collection of statistics on innovation. Without creating a system for the collection of information on the features of the innovation system, in a regime harmonised to the EU statistics system, we will only have fragmented information, and we will not be able to monitor the impacts of the various innovation related functional policies. In the first step the Central Statistics Office should be enabled to meet the requirements of the OECD and EUROSTAT concerning the collection of data on innovation.

A variety of measures should have been taken years ago to reform the application scheme: (1) 'no-name' institutions, without any material international reference, should not be permitted to win funds through application schemes and they should not be permitted to receive scarce R&D funds without technical/professional controls and without a chance of 'industrial' utilisation. (2) In the reviewing of and decision making on applications preference should be granted to institutions and companies (!) having produced and capable of guaranteeing real

30 Elimination of administrative obstacles (visa requirement etc.) in the case of the admission of foreign researchers to Hungary may be justified.

innovation performance and the detrimental practices of 'hand feeding' (when 'tenders' are organised for specifically targeted research units and where the amounts so allocated are, by the way, often ludicrously small) should be eliminated.[31] The termination of such practices needs legal regulation. Guaranteeing the predictability of regulation is particularly important in respect of the reformed conditions of competition (*Borsi–Papanek* [2002]).

The controlling of the effectiveness of the use of funds spent on R&D is on the agenda of the majority of countries, and according to the lessons drawn from the conference in Vienna on 15 and 16 May 2003 convergence in this field has already commenced. Two basic trends are observed: (i) efforts are now made to control the impact assessment of the projects of large R&D programmes at a macro-economic level as well (the regular collection of innovation competitiveness statistics, as has been mentioned, may make substantial contributions to this),[32] and (ii) assessment at the level of institutions[33] is also evolving. As a first step of this latter the role of research and development organisations within the innovation system needs to be clarified. Clarification of the social/economic role is the first step of the restoration of competitiveness. To this end, research organisations under governmental control should be requested to submit updated mission statements,[34] for the majority of such institutions either do not have such or the ones they have must have become outdated since the system change. The second step could include specification of strategic and short-term objectives involving measuring points or benchmarks that may be controlled in retrospect, in a way that may also be followed by the public. In the case of funds spent in the framework of institution financing and in the case of project tasks real impact assessment and the calling of institutions to account for performance are of importance. In the case of institutions the weight of publications as performance measurement indicators should be reduced. Instead, compliance with the objectives of innovation should be controlled. To avoid any misunderstanding, it should be noted that we see no problem in institutions of the Academy receiving the same or even larger amounts of funding under conditions of competition. What is necessary, however, is an increased emphasis on demanding

31 The current practices of the appraisal of scientific applications are excessively concentrating on the texts of the applications. This makes it possible for 'no-name' institutions to win, by offering impossible accomplishments, ahead of institutions submitting more realistic applications, that are actually capable of delivering what they promise. The weight of references should be increased in the appraisal process and realisation of the promises made by applicants should be controlled more tightly (see below).

32 Török [1998] provides an overview of technical literature and describes the aspects of R&D project appraisal though Hungarian examples as well.

33 As a matter of course, evaluation of basic research is also possible and necessary, see Arnold–Balázs [1998].

34 In this case a mission statement is a short (e.g. up to 250 words) document summing up the key objectives and functions of the institute. By having to submit it an institution may be prompted to think over its role in the economy and society. If a department of a university is, at the same time, a research unit, it has to know what and why it is researching.

results that may be utilised in the economy and that can be measured in terms of social welfare and improvement of the quality of life.[35]

Awareness is to be raised first and foremost of the fact that the protection of intellectual property (patents, brands etc.) is the most important incentive for innovation. An interest-representing organisation of owners of intellectual property should be set up and be provided with major powers. The effectiveness of processes of criminal investigation, administration of justice and execution in relation to violation of intellectual property rights should be increased substantially.

According to research findings (see *Borsi-Papanek* [2002]) at present the largest number of research units that stand no chances in EU research belong to universities. In order to improve real chances and to strengthen the competitiveness of the economy attempts will have to be made to create larger university research units, though it will be against a variety of important interests (though this will not necessarily mean the merging of departments) along with the spreading of the concept of 'enterprising universities'. Research units and their heads should be provided with all of the rights (concerning the conclusion of contracts, financial and human resource management functions) as will be required for the commercial operations of the institutions concerned and the concept of personal responsibility of managers will have to be clarified, along with the consequences of non-performance of the obligations (sanctions). The legal regulations preventing the utilisation of the intellectual property of universities (e.g. a university may not make an in kind contribution of intellectual property to a spin-off entity[36]) will have to be eliminated.

Findings of surveys (*Borsi-Papanek* [2002]) also show that Hungarian research units of enterprises generate a more balanced innovative performance and their infrastructure is definitely better than that of universities. Accordingly, the Government should rely, more than it does currently, on the opinions of researchers in the business sector when making its decisions on the R&D sector and should not exclude such units and their networks/associations from R&D subsidies either.

In view of the cooperative and collective research forms indicated in the No. 6 Frame Programme relationships and connections between domestic research units and domestic and foreign trade associations and federations should be promoted for together they stand a better chance of organising joint research projects in which it is possible to involve small and medium-sized enterprises (Brussels intends to devote 15 % of the budget of the No. 6 Frame Programme - about EUR 2.6 billion - to small and medium-sized enterprises).

In order to alleviate regional inequalities in Hungary preference should be granted to research projects carried out in cooperation between organisations in the capital city and organisations elsewhere in Hungary. This would improve

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35 In the case of state-funded R&D the setting of performance dependent and performance independent as well as short and long term R&D programmes is a task to be carried out by the government.

36 A spin-off entity is worth establishing for a research unit (or its researcher) if new knowledge has been created that is worth managing in a separate company, see Kleinheincz [2000], and EC [1998].

knowledge flows within Hungary and may reduce parallel research efforts, and on the whole it may improve the competitiveness of our research units.

Effective 'policy coordination' is indispensable for the creation of the operational frame conditions of a national innovation system. The parallel organisation building[37] envisaged by the prospective innovation act, however, would be contrary to this requirement. In some cases this is clearly a displacement activity: the former National Technical Development Committee - today: Deputy State Secretariat for Research and Development - concentrates the required professionals and could effectively operate the innovation system (after a little organisation development if necessary), if this organisation were granted the rank of a ministry, the proper legislative background and some measure of autonomy.

3.4. Closing remarks

Even if the innovation system moves towards a more effective regime of operation, it may still be possible that an innovative project finds no financing source resulting in 'sub-optimal allocation'. This would not necessarily mean a defect of the financing system. On the demand side, for instance, an innovator may not be able to produce a reliable business plan, or it may not want to share all of its information with the financing organisation. On the supply side financing organisations may not necessarily compete for innovative projects. In some cases an innovator may not find a financing organisation that is capable of 'comprehending' the project or, eventually, a financing organisation may not necessarily like the proposed exit arrangement (*OECD* [1995] p. 13).

It should be noted that **politics, as a matter of course, play an immense role in the creation of an efficient innovation system**: *Gallagher et al.* [2003], for instance, gives an excellent summary of the key components of the Irish economic upswing. For the Irish consider technology transfer as one of the most important aspect, which - together with a number of other factors - has enabled the 'economic miracle':

a.) a bit of luck and timely response: as the Irish did, Hungarians should also start 'responding';

b.) social consensus: the society accepted (for politicians made people to accept) the necessity of up-front sacrifices for long term success and nobody questioned this. The strengthening of domestic businesses followed the attraction of substantial capital in high technology sectors!

c.) strategy: software + building on knowledge + business spirit[38] combined with smooth interfacing of academy and industry, is the mixture that has brought success to the 'Celtic tiger'.

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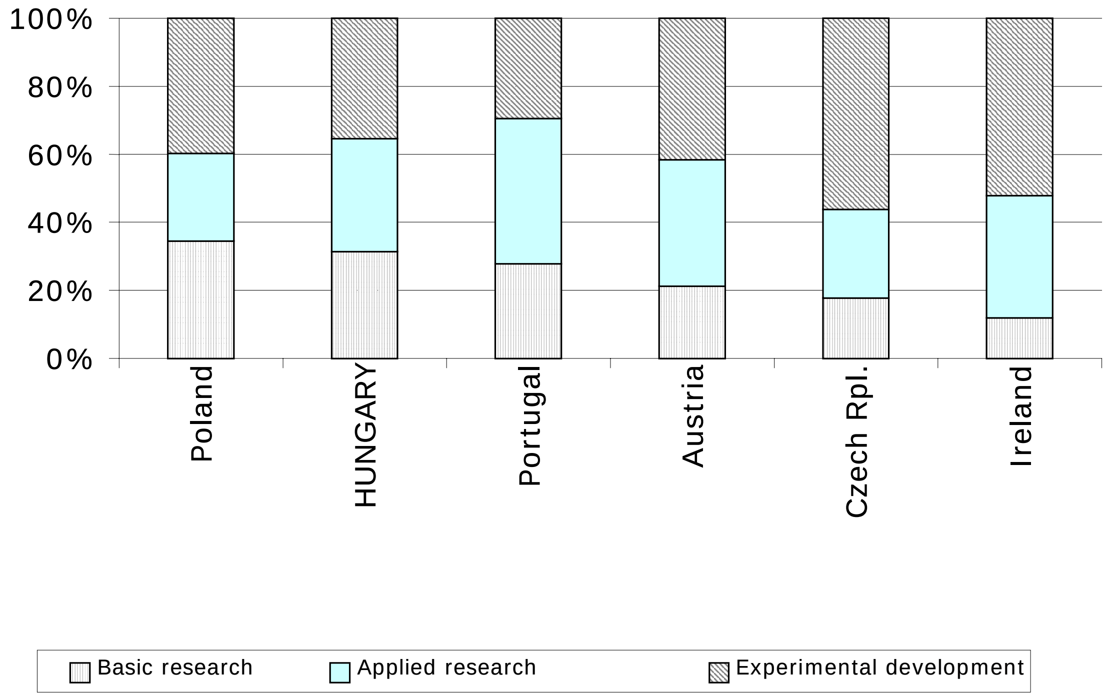
37 National Research Development and Research Utilisation Fund (Nemzeti Kutatás-fejlesztési és Kutatás-hasznosítási Alap), Research Development Application Management and Research Utilisation Office (Kutatás-fejlesztési Pályázatkezelő és Kutatás-hasznosítási Iroda) Science and Technology Cabinet or College (Tudomány- és Technológia Kabinet vagy Kollégium) etc.

38 Typically, the Irish talk about 'business minded government'.

In closing the study the author wishes to emphasise that the effectiveness of the above system of means and instruments is in close correlation with the social/political esteem of science and education. A lot of countries have been able to develop into scientific and technological powers in a very short period of time by historical standards. The lesson to be drawn from such examples - ranging from South Korea to Ireland - is that high standard education is a strategic pre-requisite for catching up and the direct recognition and awarding of knowledge (regardless of political considerations) is an indispensable requirement while thriftless (inefficient) spending of money is conductive to failure.

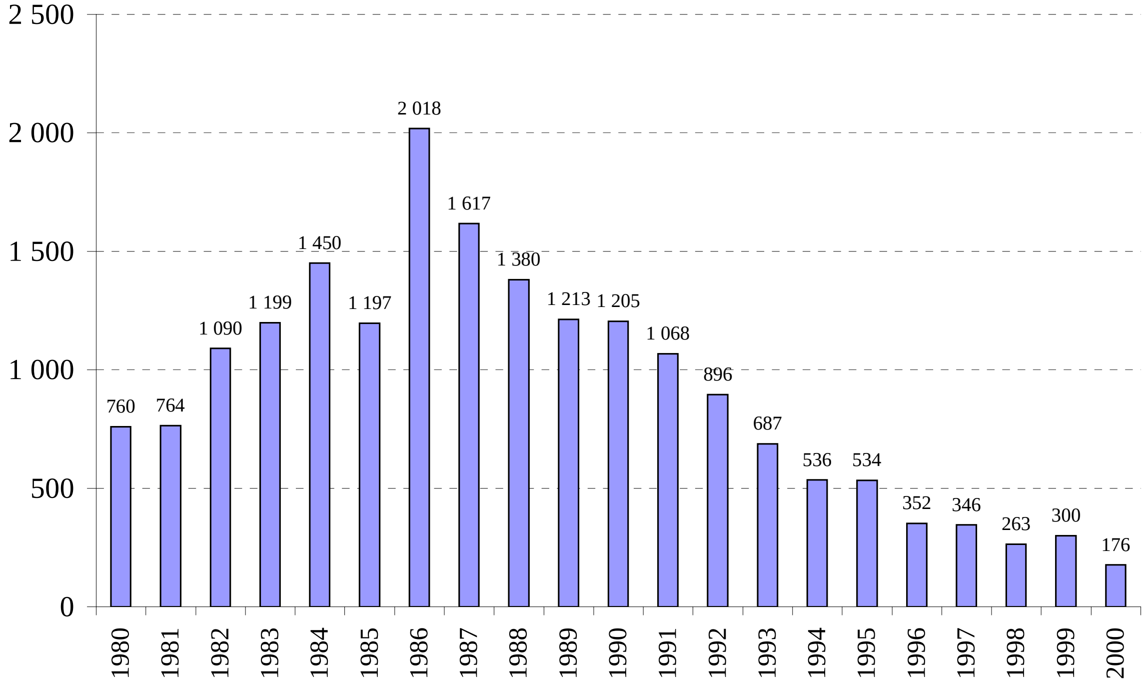
Appendices

Figure 1. Ratios of basic and applied research and experimental development in the R&D expenditures of some countries



Source: OECD [BSTS 2000]

Figure 2. Patents granted in Hungary



Source: WIPO

Table 1 EU innovation Indicators

„Benchmarking"	*„Scoreboarding"*
a.) Human resources of R&D and attractiveness of S&T professions – researchers / 1000 employees – new S&T PhD degrees / number of individuals in generation	a.) Human resources – those acquiring scientific and engineering qualifications in the 20 to 29 year age group – percentage of university graduates – participation in lifelong learning – employees of high and medium technology manufacturing branches – employees in high tech services
b.) Governmental and private sources of R&D – R&D expenditure as a percentage of GDP – sectoral (Business) R&D expenditure / sectoral output – R&D expenditure as a percentage of annual budget – share of small and medium-sized enterprises in R&D financed by government and implemented by private sector	b.) Capability of new knowledge generation – governmental R&D expenditures / GDP – business R&D expenditures / GDP – European patents constituting high technology / population – US patents constituting high technology / population
c.) Scientific and Technological productivity – per capita number of patents (US, EU) – scientific publications and citations per capita – share of innovative businesses cooperating with other businesses, universities and state research units	c.) Transfer and adaptation of new knowledge – small and medium-sized enterprises performing R&D within the fence – innovative cooperation involving small and medium-sized enterprises – innovation expenditures / total sales revenue
d.) Impact of R&D on economic competitiveness and employment – share of high and medium technology businesses of output and growth and of employment and its increase – the above ratios on knowledge intensive services – technology export as a percentage of GDP – share of high tech products in global market	d.) Innovation financing, output, markets – venture capital financing high technology / GDP – accumulated 'new' capital / GDP – share of entities selling new products in the market – Internet access at home – sale of information and communication technologies / GDP – high technology added value in manufacturing industry

Source: based on *European Commission* [2002/a, 2002/b], own table

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